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Impact of ByteDance crisis communication strategies on different social media users

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The impact of corporate crisis communication strategies on users' attitudes across different platforms has emerged as a new focal point in crisis management. This study is rooted in Social Media Crisis Communication (SMCC) and employs the case of Trump's sanctions on TikTok to analyze variations in the effects of ByteDance's crisis communication strategies on different social media platforms. We initally identified five announcements that generated significant discussions on Toutiao and Weibo and collected the corresponding user comments (a total of 50,702). Subsequently, we utilized two approaches, machine learning and deep learning, to conduct sentiment classification tests on the text to identify the best-performing model. This model was then applied on the entire dataset for sentiment classification, followed by semantic network analysis based on the sentiment classification results. The results demostrated that the pre-trained ERNIE model outperformed the other tested models (F1 = 82.40%). Following the fourth crisis communication event, users on Toutiao and Weibo exhibited contrasting sentimental tendencies. Theoretically, we observed that users on different social media platforms relying on distinct information sources, expressed different sentimental responses to the same crisis. Social media users have a tendency to anthropomorphize corporate personality traits. In practical terms, we recommend that companies engage in crisis communication on multiple social media platforms and do not overlook the most influential platforms in the market.

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Introduction

Several methods have been employed for crisis management. However, few theories and models address crisis management in an online context. The Social-Mediated Crisis Communication (SMCC) model proposed by Austin et al. (2012) is an effective method for studying crisis management in the online context. The model explains the effects of the source and form of information on response choices and proposes social media crisis response strategies. The SMCC model also describes the use of social media by individuals and organizations for spreading information during crises. Therefore, in recent years, SMCC has become a popular theory for guiding crisis communication (Zimand-Sheiner et al., 2021). SMCC overcomes the limitations of the Situational Crisis Communication Theory (SCCT) to include new media based on internet technology. It provides established suggestions on the origin of a crisis, matching information transmission forms, and crisis response strategies (Mak and Song, 2019).

Studies based on the SMCC model have demonstrated that the source of crisis information (organizations and third parties) influences the sentimental response of public to a crisis (Jin et al., 2014; Liu et al., 2011; Cheng et al., 2022). On social media, the public is more likely to accept statements from official accounts than from third-party accounts. However, the SMCC model does not account for the differences in public opinion on different social media platforms (Bruns and Burgess, 2014) or the variations in public preferences for enterprises across platforms (Arora et al., 2015). Therefore, crisis managers need to understand the impact of varing crisis communication strategies on different social media platforms.

On July 30, 2020, US President Donald Trump announced his plan to use executive orders or emergency economic powers to ban TikTok and disagreed with Microsoft's acquisition of TikTok in the US. Against the backdrop of ZTE and Huawei facing US sanctions and adopting different response strategies that resulted in similar outcomes, the Chinese public held an aversion toward enterprises that give up resistance and choose to "surrender," instead of favoring companies that engage in direct confrontation with the US government. Consequently, the US government's sanctions posed both an existential crisis for ByteDance in the US and a crisis of trust in ByteDance within China.

ByteDance, TikTok's parent company, subsequently conducted several Chinese crisis communications on Toutiao—a platform own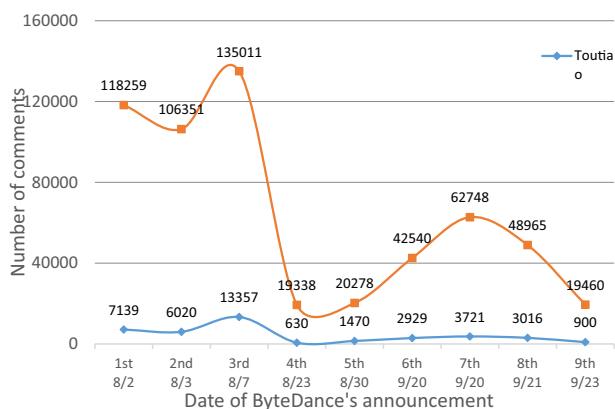ed by ByteDance that provides information to Chinese people. As shown in Fig. 1, ByteDance posted crisis communication announcements exclusively on Toutiao. However, these announcements were occasionally reposted, sometimes with rephrasing or reformatting, by third-party users on other Chinese social media platforms. These third-party users included both well-known influencers and general users. For example, the discussions became more prominent on Sina Weibo, China's largest online social media platform, than on any other platform, including Toutiao. Therefore, It is necessary to compare crisis communications across different social media platforms.

This study considered crisis communication by ByteDance on Chinese social media following the US ban on TikTok. It incorporates machine learning-based sentiment classification and semantic network analysis (SNA) into the SMCC model to compare the impact of crisis transmission on Toutiao and Weibo users from quantitative and qualitative perspectives. We investigate how users on Weibo, China's largest social media platform, and ByteDance's Toutiao engage in corporate crisis communication. The user attributes revealed by these similarities and differences can serve as a reference for Chinese enterprises in choosing platforms for crisis communication.

The remainder of this paper is organized as follows. In "Literature review", the concept of SMCC, homogeneity problem of social media, research progress on corporate crisis communication in Toutiao and Weibo, machine learning-based sentiment classification, and SNA are reviewed. The methodology of this study is described in "Method". The results of qualitative and quantitative analyses are presented in "Results". The contributions of the SMCC model and constructive recommendations for crisis management are discussed in "Discussion". Finally, in "Conclusion", the study is summarized and opportunities for future research are presented.

Literature review

This literature review outlines the fundamental concepts of this study, including the SMCC model, sentiment classification based on machine learning, and SNA.

SMCC. To effectively represent the interaction and communication relationship between the real and network worlds, SMCC divides communication media into three categories: social media, traditional media, and offline word-of-mouth communication (Liu et al., 2011). In, addition, to demonstrate the response behavior of organizations in a crisis, the SMCC model proposes five factors of crisis management in the social media environment: crisis origin, crisis type, infrastructure, message strategy, and message form. These factors directly affect communication and dialog modes in the early, intermediate, and late stages of a crisis.

Crisis origin. Crisis origin refers to whether the crisis comes from inside or outside the organization. Accurately locating the basis of a crisis directly affects responsibility attribution. The public believes that a crisis originating inside an organization is more controllable than the one originating outside the organization. Therefore, if a crisis stems from inside the organization, the organization should take primary responsibility and determine its crisis response strategy. We divided the first research question into five parts, as follows:

RQ1a: What was the origin of the ByteDance crisis in the Chinese market in the face of US censorship of TikTok?

Crisis type. In the SMCC model, crises are divided into *victim*, *accidental*, and *intentional clusters* as summarized in Table 1. In

Fig. 1 Number of comments generated by ByteDance's crisis communication on Toutiao and Weibo. After US President Trump announced the sanctions against TikTok, ByteDance issued a total of nine crisis communications, and there was much more discussion on Weibo than on Toutiao.

Table 1 Crisis types.

	Victim cluster	Accidental cluster	Intentional cluster
Attribution	The organizations are considered victims and are not blamed for the crisis.	The organizations are nominally blamed for the crisis, but stakeholders perceive the situation as unintentional or accidental.	The crisis is considered deliberate, and the organizations need to admit responsibility.
Reputational threat level	Slight	Moderate	Severe
Examples	Natural disaster Rumor Workplace violence Product tampering/malevolence	Challenges Technical-error accidents Technical-error product harm	Human error accidents Human-error product harm Organizational misdeed with no injuries Organizational misdeed management misconduct Organizational misdeed with injuries

Table 2 Message strategies of a crisis response.

Primary crisis response strategies	Deny		Diminish	Rebuild
	Attack the accuser, Denial, Scapegoat		Excuse, Justification	Compensation, Apology
Secondary crisis response strategies	Bolstering			
	Reminder, ingratiation, victimize			

the *victim cluster*, the organization is identified not as the cause of the crisis, but as a victim. In the *accidental cluster*, the organization is nominally identified as the cause of the crisis, but stakeholders often view the situation as unintentional or accidental. In *the intentional cluster*, the organization is assigned an entire or majority attribution and takes full responsibility for the crisis. Different crises require different communication strategies.

After identifying the type of crisis (cluster), managers can predict the attribution and reputational threats to an organization. This leads to the second part of the first research question.

RQ1b: What type of crisis was ByteDance facing in the Chinese market?

Infrastructure. Infrastructure refers to the management model adopted by an organization to manage a crisis, including centralized departments for unified handling and separate branches for independent handling. The third part of our first research question was as follows:

RQ1c: What was ByteDance's organizational management model for its crisis communication?

Message strategy. Table 2 outlines the possible message strategies for crisis responses. An organization can identify the best strategy for crisis communication by identifying crisis types and attributes. The SMCC model divides the message strategies into three types: *denying, diminishing*, and *rebuilding*. *Deny* response strategies include attacking the accuser, denying the accuser, and using a scapegoat. *Diminished* response strategies include excuses and justifications. *Rebuilding* response strategies include providing compensation and an apology.

The communication decisions made by crisis managers after a crisis can significantly impact the situation, whether positively or negatively. Therefore, crisis managers must adopt appropriate crisis communication strategies to safeguard their organization's reputation. This leads to the fourth part of our first research question.

RQ1d: What message strategy did ByteDance adopt in its crisis communication?

Message form. Message form refers to the way of transmitting the crisis information. The SMCC model proposes three types of communication: social media, traditional media, and offline word-of-mouth. The final part of our first research question was as follows:

RQ1e: What message form did ByteDance use to transmit its crisis information?

Social media. Crisis managers can effectively adjust an organization's crisis communication strategy using SMCC to identify users who exhibit different active states during a crisis. The SMCC model divides social media users into three categories according to differences in their performances: *influential creators*, *followers*, and *inactives*.

Influential social media creators actively create information for others. This type of user has considerable influence on many followers. For example, authoritative institutions, mainstream media, and celebrities have accounts on Sina Weibo. *Social media followers* are direct consumers of the information created by influential social media creators. *Social media inactives* indirectly consume crisis information created by influential social media creators; however, they only pay attention to information after repeated forwarding or reprocessing. This leads to the second research question.

RQ2: Who were the most influential social media users of Toutiao and Sina Weibo during the ByteDance crisis?

Overall, crisis origin, type, infrastructure, and message strategy underpin an organization's crisis communication strategy throughout the crisis cycle.

Homogeneity of social media platforms. Social media has become one of the most common methods for crisis communication (Fraustino et al., 2017; Zhou et al., 2021; Jiao et al., 2017; Kim et al., 2010). However, ignoring the potential risks of social media, which may lead to a second crisis, is impossible (Mak and Song, 2019).

For a long time, researchers have tried to identify the relationship between social media users and communication strategies (Eriksson, 2012). Subsequently, their findings were generalized to all social media platforms. This was acceptable in the early developmental stages of social media platforms. However, as the growth rate of new social media users gradually decreased, each platform formed a fixed user group.

However, this does not imply needlessness of comparing social media platforms. By contrast, we can enhance the original theory

and increase its adaptability to practical applications by comparing different communication mechanisms and influences on crisis communication among social media platforms. For example, studies comparing Facebook and Twitter have been a prevalent topic in crisis communication.

One study found significant statistical differences in the age and gender composition of users of different social media platforms (Chan-Olmsted et al., 2013). These differences in user attributes may lead to a perception bias in crisis information (White, 2011). Additionally, owing to the differences in the basic functions offered by Facebook and Twitter, users have different perceptions of usefulness. For example, Facebook uses a two-way communication model during crises. However, Twitter uses an unequal, one-way communication model. The upper and lower structures are composed of the followed and followers, respectively. This is an essential difference in the mode of communication of crisis information between plat-forms and the way their users perceive the information (Bruns and Burgess, 2014).

In addition, owing to various factors, a limited comparative research is available on crisis communication between social media platforms other than Facebook and Twitter, especially in the Chinese language. Only a few competitive Chinese social media platforms exist, and a single product can easily monopolize a specific vertical field. However, with ByteDance's rapid growth in the Chinese market, Toutiao was flooded with a sufficiently objective user group, creating competitive pressure that Sina Weibo, currently the largest social media platform in the Chinese mainland market, could not ignore. ByteDance released official statements on Toutiao, which resulted in significantly more discussions on Weibo than on Toutiao after being reprocessed by third-party users. Therefore, this study conducted a comparative crisis communication analysis between Toutiao and Sina Weibo. Therefore, the research question was as follows:

RQ3: Do Toutiao and Weibo users have different attributes?

Toutiao and Weibo in corporate crisis communication. As of April 2022, comparative studies of corporate crisis communication on Chinese social media are still in their infancy. In addition, no research has focused corporate crisis communication using Toutiao as a social media platform. By contrast, articles focusing on Weibo are mainly divided into the following categories: 1) the effectiveness of crisis communication strategies and 2) the context that affects the choice of strategy. SCCT is the most frequently used framework.

The SCCT is one of the most trusted frameworks for exploring the effectiveness of crisis communication strategies. Wang (2016) investigated social media advertising used by companies for crisis communication based on SCCT. The results showed that "acting cute" can effectively reduce the negative impact of brand crises and gain public sympathy and support. Based on SCCT, Che et al. (2022) explored effects of corporate crisis communication strategies on users' attitudes. The results showed that diminishing strategies did not change the users' negative attitudes, whereas rebuilding strategies increased the users' positive sentiments. Attribution theory, the seven-step crisis management method, and image restoration are critical frameworks. Jiang et al. (2015) integrated the concept of in-group/out-group orientation based on the attribution theory to examine public responses to crises. The results demonstrated inclusion strategies to be more acceptable than alienation strategies irrespective of the determi-nation of responsibility attribution by public. Ngai and Jin (2016) investigated effects of crisis communication strategies on stakeholder sentiment using a seven-step crisis management approach. The results showed that the use of accommodative and

defensive strategies could prevent crises from worsening in the early stages of post-crisis dissemination. Su et al. (2019) examined the response of crisis communication to the public from the perspective of image restoration. The authors focused on categorizing differences in terms of time, space, topic, and gender retrieved from corporate crisis communications and online comments. This study shows that Weibo users' partial and personal intimacy had a moderating effect on the impact of public events.

Zhao (2017) explored the impact of context on SCCT strategies from the perspectives of the rhetorical arena and framing theory. The results showed that companies should choose strategies based on their contexts. Finally, Zhao (2020) examined the impact of the national context on crisis attribution based on the SCCT. The results empirically support the view that the context outside the organization has a significant impact on crisis attribution.

From the above analysis, unprecedentedly, the present study used SMCC to conduct a comparative analysis of Toutiao and Weibo to fill the gap in the comparative analysis of crisis communication in the Chinese environment. This exploratory public opinion study was based on Toutiao.

Sentiment classification based on machine learning. Crisis managers face challenges in comprehensively and appropriately understanding user attitudes and opinions. This enables enter-prises to effectively use the most suitable crisis communication strategy (Kuipers and Schonheit, 2022; Kim and Kim, 2018). However, methods for determining and classifying user senti-ments based on natural language processing (NLP) and machine learning have helped crisis managers select suitable crisis com-munication strategies (Blanco and Lourenço, 2022).

Sentiment classification has been studied extensively in sentiment analysis and viewpoint mining (Gulati et al., 2022). It comprises subjective, objective, and sentiment polarities (Sun et al., 2021). Subjective and objective classifications arrange texts into subjective and objective categories, respectively (Zhao et al., 2021). Subjective texts contain the author's attitude, position, or viewpoint, whereas objective texts do not contain any viewpoints or opinions (Li et al., 2022). Sentiment polarity classification is based on positive and negative biases (Cai et al., 2022). Depending on the application, sentiment polarity can be further divided into long- and short-text sentiment classification. This study adopted short-text sentiment classification (Zhang et al., 2021).

Lexicon-based and machine-learning-based methods have been applied to both short- and long-text classifications (Gulati et al., 2022). Lexicon-based sentiment classification judges the senti-ment polarity of texts using the sentimental tendencies of words, where the analyzed objects are text words (Hota et al., 2021). First, the positive or negative directions of the words or phrases must be identified. Words or phrases are considered as words, and the sentimental polarity of the entire text is obtained using a weighted sum of the positive or negative degrees of words or phrases. Machine-learning-based sentiment classification requires preprocessing, text representation, and classifier training before finally outputting an sentimental polarity prediction (Gulati et al., 2022).

Only one study that combined SMCC and lexicon-based sentiment classification was reported in 2021. Obembe et al. (2021) explored the influence of tourists' sentiments on the trends and performance of airlines, tourism, key institutional actors, and news sentiments. However, lexicon-based sentiment classification also has a problem that cannot be ignored: the sentiment lexicon can only calculate the sentiment polarity of the text itself but
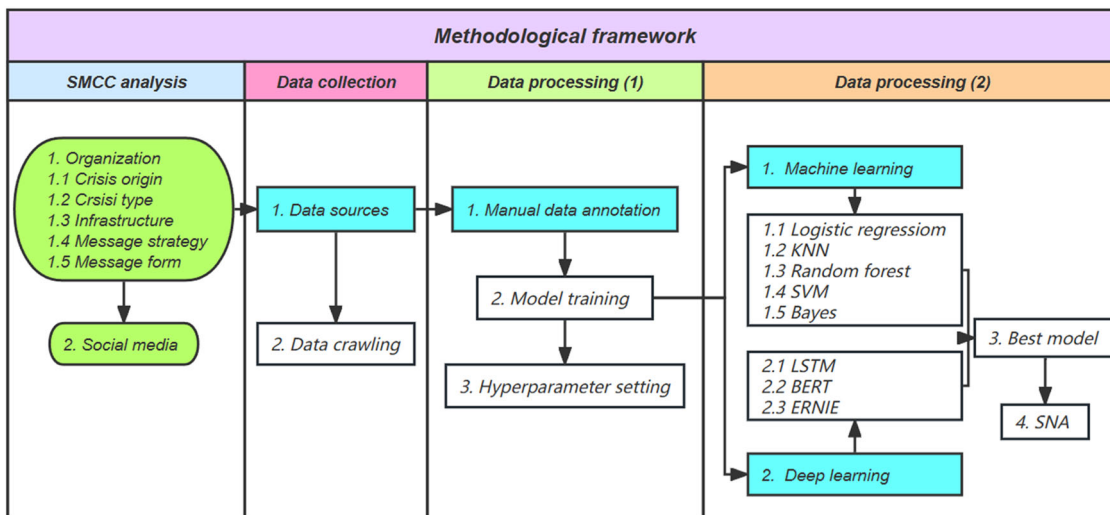
Fig. 2 Methodological framework. The figure shows the four components of this research method and the main work content of each part.

cannot specify the object pointed to by the sentiment of the text. For example, in an argumentative event involving subjects A and B, the sentiment dictionary calculates the sentiment polarity of comment C as positive. However, it cannot determine whether the positivity of comment C is directed toward subject A or B. This is fraught with significant hurdles for corporate crisis managers, who develop crisis communication strategies by analyzing public opinion. However, machine learning-based sentiment classification can address this shortcoming. When we set subject A as our research object, machine-learning-based sentiment classification can realize the classification of texts favorable, unfavorable, and irrelevant to subject A as positive, negative, and neutral, respectively, to construct a classification criterion completely different from lexicon-based sentiment classification. This greatly reduces the uncertainty of the sentiment polarity of the text. Therefore, machine learning was selected as the sentiment classification method in this study.

ByteDance published official statements on Toutiao. However, the ferment of public opinion originated from posts by influential social media creators on Weibo. This raises the following question: Do noticeable differences exist between the sentiments of comments on Toutiao and Sina Weibo? Furthermore, is the content of the comments different? The answers to these questions affect the route the organization chooses when making crisis statements. This leads to the fourth research question.

RQ4: Did ByteDance's five crisis communications published in Toutiao have different effects on the attitudes of Toutiao and Sina Weibo users?

Semantic network analysis (SNA). Latent Dirichlet Allocation (LDA) and its various improved models are the most popular methods for topic analysis. Although LDA topic model analysis can quickly divide an article into a certain number of topics, the words in the topic are all discrete, and the connections and relationships between words are lost, which makes naming these topics difficult. In addition, when analyzing short texts, although LDA can cluster topics according to the number of topics, in the perplexity visualization stage, perplexity may show an abnormal phenomenon that has been increasing. This is owing to the special sparsity of short texts, and traditional LDA or probabilistic latent semantic analysis are not ideal for analyzing short texts.

With the rapid development of social media, SNA has become one of the most widely used methods of crisis communication (Park and Kim, 2021). SNA can be organized to graphically

represent the quantitative relationships between words. Further qualitative analyses (Liu et al., 2018) can be conducted on the potential structure of words based on quantitative indicators (Drieger, 2013). In recent years, SNA has become a widespread method for exploring social media essays during crises (Yoo et al., 2019).

The fifth research question of this study is:

RQ5: What topics did Toutiao and Weibo users use in response to ByteDance's crisis communication?

Method

The methodological framework of this study is illustrated in Fig. 2. The present study comprises four steps: SMCC analysis, data collection, data processing, machine learning-based sentiment classification, and SNA.

SMCC analysis. We used the SMCC model to conduct a comprehensive qualitative analysis of organizations and social media. Furthermore, we identified information regarding *crisis origin, crisis type, infrastructure, message strategy, message form,* and *influential social media creators.*

Data collection

Data sources. ByteDance used its official Toutiao account for all crisis communication announcements; therefore, Toutiao was selected as the data source to explore the impact of official accounts on public opinion. Weibo was selected as the data source to explore the impact of unofficial accounts on public opinion as the ByteDance announcement was retweeted by self-publishers on Weibo, which generated more lively discussions on Weibo than on Toutiao.

Data crawling. Octoparse was used to crawl relevant information and comments from Toutiao and Sina Weibo (Ahamad et al., 2017). Table 3 presents the data sources and their respective volumes. The "No." column represents the five selected official announcements, while the "Release Date" column indicates the dates of publication for each announcement. All the comments were sourced from a single account. "Toutiao" refers to ByteDance's official website account, while "Weibo" denotes the top five third-party accounts that generated the highest discussion volume for each of the five announcements.

First, we identified the five crisis communication statements posted by ByteDance that generated murmur on both Toutiao

Table 3 Number of comments generated by ByteDance's fourth announcement on Toutiao and Weibo.

No.	Release Data	Toutiao		Weibo	
		Account	Comments	Account	Comments
1	August 2, 2020	ByteDance	3698	Sina Tech	12466
2	August 3, 2020	ByteDance	3270	Sina Tech	5064
3	August 7, 2020	ByteDance	13000	Guancha syndicate	1162
4	August 23, 2020	ByteDance	630	People's Daily	7781
5	September 20, 2020	ByteDance	2943	Global Times	688

Table 4 Cross-section of metadata crawled from Weibo.

Link	https://weibo.com/1642634100/JebZ5rcJw?filter=hot&root_comment_id=0&type=comment#_rnd1636432567419
User ID	新浪科技
Publication time	2020/8/3 13:19:00
Post content	#张一鸣内部信#【张一鸣内部信: 不放弃探索任何可能性 正与一家科技公司讨论方案】…
Number of shares	843
Number of comments	5070
Number of likes	49916
Commenter ID	小鸟真的超级可爱
Comment content	张一鸣当初夸美国可以争论, 不像国内一边倒的批评。现在啪啪打脸, 怎么不和美国据理力争了啊？？
Number of likes for comments	7939

Table 5 Composition of the data set after stratified sampling.

	Toutiao			Weibo		
No.	Original dataset	Ratio	New subset	Original dataset	Ratio	New subset
1	3698	7.29%	270	12,466	24.59%	3065
2	3270	6.45%	211	5064	9.99%	506
3	13,000	25.64%	3333	1162	2.29%	27
4	630	1.24%	8	7781	15.35%	1194
5	2943	5.80%	171	688	1.36%	9
Total	23,541	46.43%	3992	27,161	53.57%	4801

and Weibo and then crawled the data from each of the two platforms. The data on Toutiao were the comments in the comments section of the five announcements posted by ByteDance's official account on Toutiao, whereas the data on Weibo were the comments on the post with the highest number of comments in each of the five announcements.

Table 4 presents the metadata obtained from our web crawling, including the post link, user ID, post publication time, post content, number of shares, number of comments, number of likes, commenter ID, comment content, and number of likes of comments. In alignment with our research objectives and to ensure user privacy protection, we retained the number of likes of posts and comment content to facilitate the identification of the most popular posts and for subsequent computational analyses, while other components were removed.

As shown in Table 5, 50,702 data points were obtained for the entire dataset. Considering the efficiency of the manually labeled data, 8793 data points were obtained after stratified random sampling of the dataset.

Data processing

Manual data annotation. In this study, a comprehensive annotation plan was developed to ensure the systematic and unbiased annotation of comment polarity. The plan included clear guidelines and specifications for the annotators to follow, which were provided as an annotation guide (Supplementary Material).

To minimize potential bias in the annotation process, five PhD students (annotators A, B, C, D, and E) from diverse disciplinary backgrounds were recruited. This diversity was aimed at mitigating individual biases and promoting a comprehensive assessment of comment polarity.

Before proceeding with the annotation task, all the annotators familiarized themselves with the annotation guide to ensure a shared understanding of the criteria for classifying comment polarity. This step was aimed at enhancing consistency and reducing subjectivity.

Subsequently, annotators A, B, and C independently assessed the polarity of each comment, assigning it as positive, neutral, or negative, based on ByteDance's perspective. In case of an agreement among all three annotators, the annotation results were considered final. In case of discrepancies, annotators D and E contributed to their judgments (Uma et al., 2021). The final annotation result was determined based on the polarity judgment of the comment with the most consistent annotation results, utilizing Holsti's coefficient reliability to ensure a high level of agreement (reaching 0.9).

To further enhance the credibility of the comment-polarity judgment, an inclusion of only non-controversial comments was prioritized. This approach was aimed at minimizing potential biases stemming from ambiguous or contentious content (Table 6).

Table 7 shows the labeled data, from which we obtained 2403 positive, 3200 neutral, and 3190 negative comments.

Model training. Given the novelty of this study of unprecedented examination of crisis communication across various social media platforms in the Chinese context, we employed a comprehensive approach that encompassed both machine and deep learning methodologies. By employing multiple approaches, we explored the effectiveness of different models in analyzing sentiments.

Within the realm of machine learning, we trained and compared five widely recognized classifiers, namely support

Table 6 Examples of text polarity determination criteria for manual labeling.

Comments	Polarity	Judgment logic
Supporting overseas rights protection of Chinese enterprises	Positive	Supporting TikTok
Don't sell it to the US First evacuate to Europe, and then try to fight back.	Neutral	This comment is only a suggestion for the content of ByteDance's announcement, no direct sentimental expression of ByteDance
He wants to internationalize, forgetting that his roots are in China.	Negative	The CEO made a decision that violated his Chinese identity
The last global company was called Lenovo	Negative	Although the content of this review has nothing to do with ByteDance, Lenovo is synonymous with negative in the Chinese context, so the polarity is negative
Worldwide? May have to lose the Chinese market!	Negative	Sarcastic tone

Table 7 Composition of text polarity after manual labeling.

Polarity	Positive	Neutral	Negative
Quantity	2403	3200	3190

vector machine (SVM), random forest, logistic regression, Bayes, and k-nearest neighbors. These classifiers were selected based on their proven success in sentiment analysis tasks and their ability to handle diverse data patterns.

Furthermore, we used the state-of-the-art deep learning models, long short-term memory (LSTM) and bidirectional encoder representations from transformer (BERT) models, which have gained substantial popularity owing to their impressive performance across various NLP tasks. Additionally, we incorporated large-scale knowledge-enhanced pre-training for language understanding and generation (ERNIE), a model known for its exceptional proficiency in Chinese natural language processing (Che et al., 2023; Che and Kim, 2023). These deep learning models were selected for their capability to capture complex linguistic patterns and contextual information.

To determine the most effective sentiment classifier, we conducted extensive tests and evaluations of these machine- and deep-learning models. Based on the evaluation results, the model that exhibited the highest performance in sentiment classification was identified as the optimal choice.

Hyperparameter setting. Grid search is a common parameter-tuning method, used to optimize the model by traversing different combinations of hyperparameters. In grid search method, all the parameters are traversed and the best model is selected. For example, if the rbf kernel is used in an SVM, the tuning range of C is set to [1, 10, 100], and the range of gamma is set to [0.001, 0.0001], then there are $3 \times 2 = 6$ combinations of hyperparameters, and a grid search is used to traverse these six combinations and find the value of the hyperparameter in which the model performs best.

SNA. We conducted SNA based on the outcomes of sentiment classification using the following methodology:

1. We employed the Term Frequency–Inverse Document Frequency (TF-IDF) algorithm to extract the top 50 words from each of the positive, neutral, and negative datasets.
2. Based on the co-occurrence relationships among these 50 words, we constructed a one-dimensional co-occurrence matrix.
3. Subsequently, we utilized Gephi, a software tool widely used for network analysis and visualization, to perform clustering and visual analyses of the obtained one-dimensional co-occurrence matrix.

For clustering, we employed the Louvain algorithm, which is a fundamental clustering algorithm integrated into Gephi. Additionally, the determination of clustering topics required a subjective interpretation of the context, and in this study, domain experts in SNA were involved in identifying topics.

Results
SMCC analysis
Crisis origin (RQ1a). On July 30, 2020, the US President Donald Trump announced his plan to ban TikTok and oppose Microsoft's acquisition of TikTok in the US. This prompted a crisis for ByteDance, resulting in several crisis communications in Chinese on Toutiao. However, several controversial issues with ByteDance's crisis communication content stimulated long-term and extensive attention and discussion among Chinese social media users.

Crisis type (RQ1b). We found that the crisis information regarding TikTok originated in the US and subsequently spread and was provoked on social media platforms, eventually leading to ByteDance's official account clarifying rumors. Therefore, in this study, the role of ByteDance was that of a victim cluster.

Infrastructure (RQ1c). The screening results of the selected information sources indicated that ByteDance selected its official account on Toutiao for centralized crisis communication.

Message strategy (RQ1d). First, to compare the sentimental impact of the same crisis communication on users of different platforms, we screened all crisis communication announcements from ByteDance and retained only those that simultaneously generated controversy on Toutiao and Weibo. Table 8 outlines the five crisis communication announcements retained after filtering.

Second, we coded crisis communication announcements based on the SCCT to identify the strategy adopted by each crisis communication.

Finally, we concluded that ByteDance used only two crisis communication strategies: *Deny* (three times) and *Diminish* (two times). Throughout, ByteDance emphasized that the entire incident resulted from political oppression by the US government, with whom ByteDance was trying to communicate.

Message from (RQ1e). ByteDance primarily used social media platforms and released nine crisis communication announcements through its official accounts on Toutiao. Crisis communication was informational and disseminated within a day of the crisis or the spread of rumors on social media.

Social media (RQ2). According to the user attributes of Sina Weibo, influential social media creators can be divided into four

Table 8 Content and strategies for crisis communication released by ByteDance that generated murmur on Toutiao and Weibo.

No.	Release date (2020)	Announcement content	Crisis response strategies	
1	8/2	ByteDance has always strived to be a global company.	Diminish	Justification
2	8/3	Zhang Yiming: Strive for the best and don't give up exploring any possibilities	Diminish	Justification
3	8/7	ByteDance's statement regarding the US Government executive order	Deny	Attack the accuser
4	8/23	ByteDance formally sued the Trump administration	Deny	Attack the accuser
5	9/20	Explanation of some false rumors about TikTok	Diminish	Justification

Table 9 The most influential third-party users on Weibo.

Type	Organization	Media	Journalist	Netizen
Influential social media creator	The rule of law in Sichuan	Global times	Cattle to play the piano	Carrier of a secret
Number of retweets	2458	18,013	31,714	1695

Table 10 Hyperparameters setting for machine learning algorithms.

Algorithms	Hyperparameters setting			
Logistic Regression	Penalty = l2	C = 1	Solver = liblinear	Max_iter = 1000
	Multi_class = ovr			
KNN	Algorithm = auto	Leaf_size = 30	Metric = minkowski	N_jobs = 1
	N_neighbors = 5	P = 2	Weights = uniform	
Random Forest	Criterion = gini	Max_depth = 10	Max_features = 4	Min_samples_split = 6
	N_estimators = 100			
SVM	C = 1	Gamma = 1	Kernel = rbf	Epsilon = 0.1

core communication types: organizations, media, journalists, and netizens. The posts were classified as per the number of posts forwarded. The posts with the highest number of forwards in each category were selected based on the four abovementioned categories. Finally, posters were determined for each post. Table 9 summarizes the results.

The core communication organization was "The Rule of Law in Sichuan," whose post was forwarded 2458 times. The core communication media was "Global Times," to which the posts were forwarded 18,013 times. The core communication journalist was "Cattle to play the piano," whose post was forwarded 31,714 times. The core communication netizen was "Carrier of a secret," whose post was forwarded 1695 times.

Sentiment classification based on machine learning and deep learning (RQ4). Table 10 presents the hyperparameter settings for machine learning and Fig. 3 illustrates the F1-scores of the five classifiers. The results indicated that logistic regression achieved the highest performance among the machine learning classifiers with an F1-score of 62.2%.

Table 11 lists the hyperparameter settings for deep learning, and Fig. 4 illustrates the F1 scores of the three deep learning models. The results indicated that among the LSTM, BERT, and ERNIE models, ERNIE achieved the best performance as a classifier, with an F1-score of 82.4%. Therefore, ERNIE was selected as the sentiment classification model for this study and further analyzed.

Figure 5 displays users' feelings after the fourth crisis communication; these results show opposite trends on different platforms. After the release of the fourth crisis communication, the positive sentiment ratio of Toutiao users continued to show an upward trend ($49.16 \rightarrow 86.15\%$). However, on Weibo, it showed a significant decline ($72.31 \rightarrow 24.34\%$). Furthermore, by observing the changes in the neutral and negative sentiments, we found that the proportion of neutral ($27.69 \rightarrow 33.00\%$) and
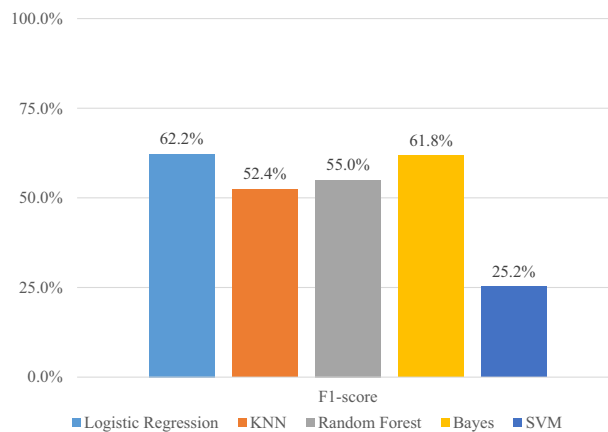

Fig. 3 F1-score of five machine learning algorithms. The larger the value, the better the classification effect of the algorithm.

negative sentiments ($0.00 \rightarrow 42.66\%$) on Sina Weibo increased, with the negative sentiments growing significantly. Hence, the reason of the fourth crisis communication resulting in stark differences on the different platforms must be thoroughly explored.

SNA (RQ5). As shown in Fig. 5, the sentiment trends of Toutiao and Weibo showed opposite results (the positive proportion of Toutiao increased significantly, while that of Weibo decreased significantly) after the fourth crisis communication. Therefore, we used SNA to explore the topics used by the users of the two platforms in discussions. Table 12 presents the descriptive parameters of the SNA diagrams.

Positive comments on Toutiao and Weibo. As shown in Fig. 6 and Table 13, the positive comments on Toutiao consisted of five

topics. Among these, purple accounted for 41%, making it the largest topic, followed by light green at 25%, blue at 18%, orange at 10%, and dark green at 6%. By reading the text, we found that the collection of positive comments indicated that Toutiao users strongly supported ByteDance's crisis communication decisions, regardless of ByteDance's global development direction or the plan to relocate TikTok's headquarters. Evidently, Toutiao users worshiped Zhang Yiming.

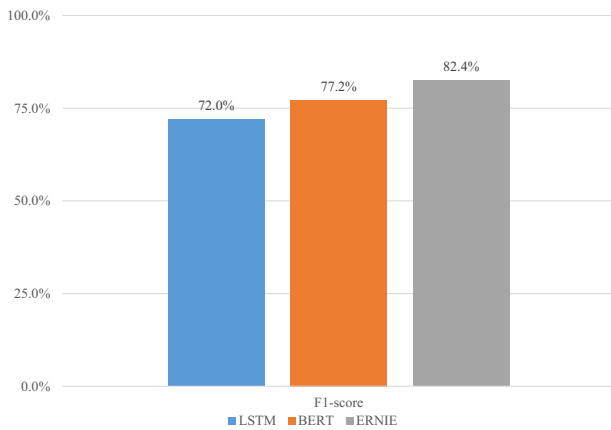Weibo users made no positive comments on the crisis communication discussions.

Fig. 4 F1-score of five deep learning algorithms. The larger the value, the better the classification effect of the algorithm.

Neutral comments on Toutiao and Weibo. As shown in Fig. 7 and Table 14, neutral comments on Toutiao consisted of two topics in nearly equal proportions: the green (51%) and pink (49%) topics. Through text analysis, we found that the core viewpoint of the green topic was that ByteDance was still based in Beijing, with TikTok's headquarters were moving out of the US. However, the pink topic believed that TikTok's withdrawal from the US market could safeguard other markets. Toutiao users were more inclined to objectively explaining ByteDance's crisis communication content using neutral comments and denying rumors. For example, some Toutiao users believed that ByteDance was moving its headquarters from Beijing to Europe. By contrast, other neutral Toutiao users emphasized that ByteDance was merely moving TikTok's headquarters out of the US, but not to Beijing. Additionally, Toutiao users believed that TikTok's withdrawal from the US market would ensure the safety of other overseas markets.

Figure 8 and Table 15 present the neutral comment sets on Weibo, which consisted of six topics, two of which were the most significant. The first was the purple topic, accounting for 34%, which emphasized patriotism as the bottom line of enterprise development. The second was the light green topic, comprising 26% of the comments. Its content revolved around ByteDance selling its share in the US market to minimize losses. Following this, blue and brown topics had nearly equal proportions, reaching 16% and 14%, respectively, whereas dark green and pink topics accounted for 6% and 4%, respectively. These results indicated that Weibo users associated patriotism with corporate development. First, Weibo users believed that the globalization of enterprises cannot be achieved without the support of the US and that Zhang Yiming is pro-American. Second, some Weibo users

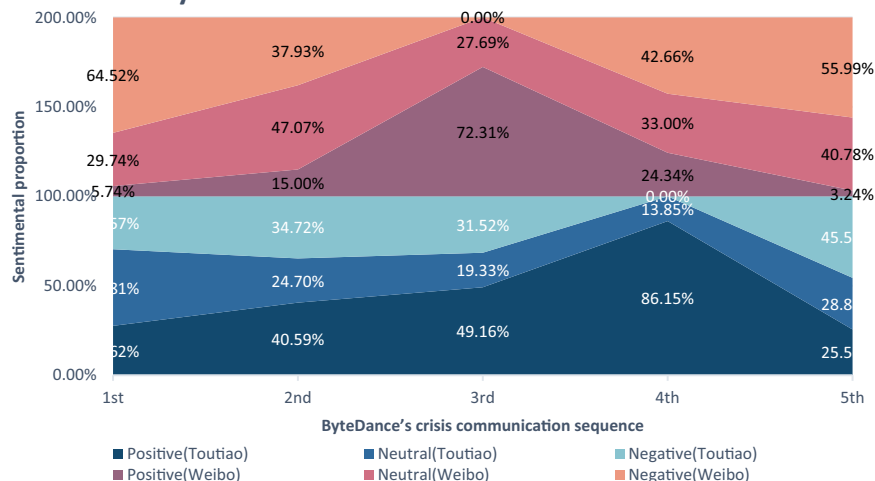| Table 11 Hyperparameters setting for different deep learning algorithms.			
Algorithm	**Hyperparameters setting**		
LSTM	Hidden units=256	Learning rate=0.001	Epochs-20	Regularization parameter=0.001
BERT	Learning rate=2e-5	Batch size=16	Maximum sequence length=256	Iterations=10
ERNIE	Learning rate=2e-5	Batch size=16	Maximum sequence length=256	Iterations=10

Fig. 5 Sentimental fluctuation of Toutiao and Weibo users after ByteDance's crisis communications. The crimson segment elucidates the sentiment fluctuation curve of Toutiao, while the azure segment delineates the sentiment fluctuation curve of Weibo.

saw Trump's administrative crackdown on TikTok as a violation of the US free trade.

Negative comments on Toutiao and Weibo. Figure 9 and Table 16 show a compilation of negative comments on Toutiao, which encompassed three topics. First, the purple topic, accounting for 40%, expresses the viewpoint "It is better to get out of the US market than sell to Microsoft." Second, the orange topic, constituting 35% of the comments, discusses "Moving TikTok's headquarters to London will not work either." Finally, the green topic, comprising 25% of the comments, raised concerns about "If ByteDance sells TikTok's American company, the Chinese government will take over ByteDance." These results indicate that Toutiao users disagreed with ByteDance's global strategic decisions during crisis communications. For example, some Toutiao users believed no difference existed between moving TikTok's global headquarters to London and staying in the US. These users disagreed with the sale of ByteDance's American TikTok

branch to Microsoft, since it could have led to dissatisfaction with the Chinese government.

Figure 10 and Table 17 present a compilation of the negative comments on Weibo, which encompassed seven topics, with the two largest topics being the purple topic, accounting for 25%, and the light-green topic, accounting for 20%. The core viewpoints of these two topics were "If ByteDance sells to the US market now, the US allies will ask ByteDance to sell to their markets in the future" and "Zhang Yiming is Pro-American,". Following this, blue, orange, and gray topics constituted 17%, 14%, and 13%, respectively, and pink and dark green topics had the lowest proportions of 7% and 4%, respectively. The results indicate that Weibo users disapproved of ByteDance's decision to sell TikTok's US branch to Microsoft. The users posted that if ByteDance sold TikTok to Microsoft, America's allies would use the same method to obtain ByteDance and sell their market share in their own countries. Weibo users attacked Zhang Yiming, regarding him as a pro-American and coward. Weibo users associated patriotism with corporate development through neutral comments. Some Weibo users believed that the globalization of enterprises could not be achieved without the support of the US, and others saw Trump's administrative crackdown on TikTok as a violation of the US free trade.

Discussion
Theoretical contribution. This study added the impact of different social media platforms on public sentiments to the SMCC model. The affiliation relationship between the organizations in crisis and social media used by organizations for crisis communication affects public opinion.
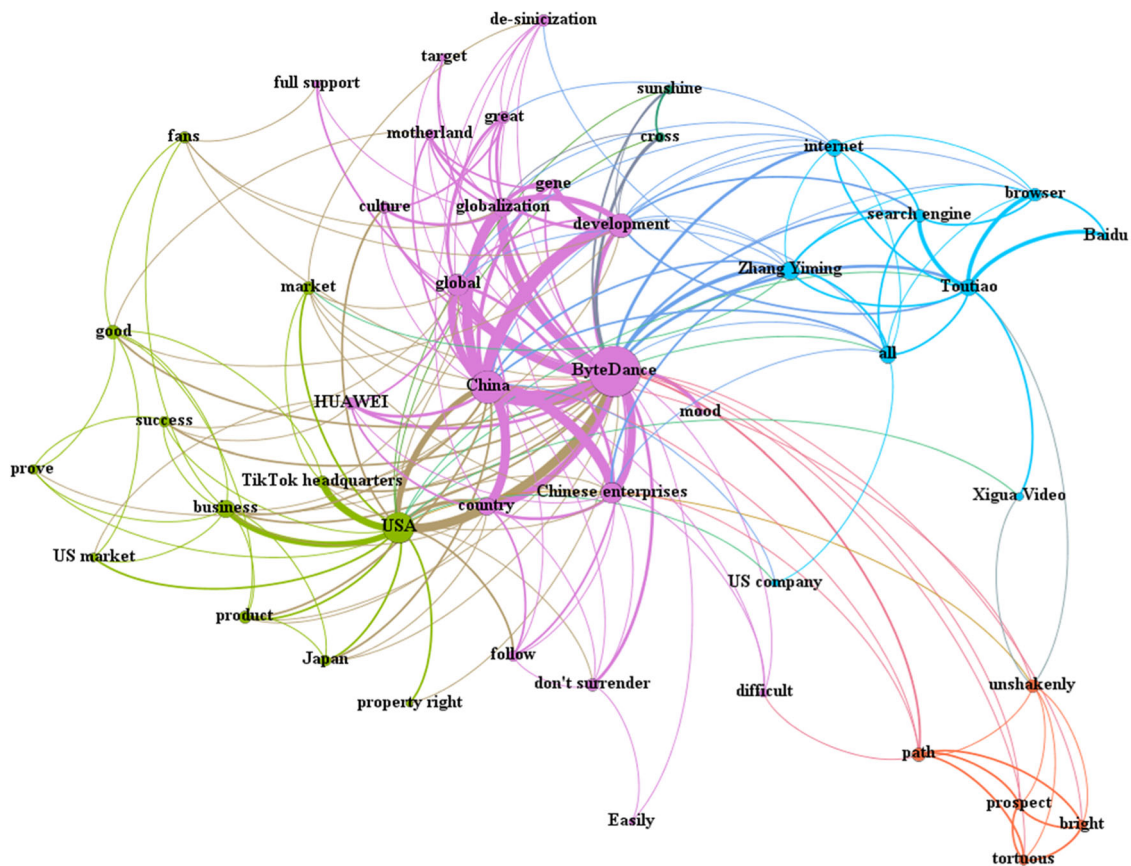
No.	Nodes	Edges	Average degree	Average weighted degree	Modularity
1	48	205	8.542	36.083	0.468
2	49	439	17.918	167.592	0.491
3	48	237	9.875	62.750	0.468
4	49	189	7.714	40.898	0.568
5	45	115	5.111	14.400	0.63

Table 12 Topics for positive comments on Toutiao.

Fig. 6 Semantic network of positive comments on Toutiao. The network indicates that there are five communities.

Table 13 Topics for positive comments on Toutiao.

No.	Topic descriptions	Colors	Ratios
1	Toutiao users support ByteDance's global development direction	Purple	41%
2	Toutiao users believe TikTok would be better off with its headquarters outside the USA	Light green	25%
3	Toutiao users support all of Zhang Yiming's products.	Blue	18%
4	The future is bright, but the road is tortuous.	Orange	10%
5	Sunshine after wind and rain.	Dark green	6%

Table 14 Topics for neutral comments on Toutiao.

No.	Topic descriptions	Colors	Ratios
1	ByteDance is still based in Beijing, just moving TikTok's headquarters out of the United States.	Green	51%
2	TikTok's withdrawal from the US market could keep other markets safe.	Pink	49%

We found that users of different social media platforms had different sentimental responses to the same crisis, based on different information access channels. In our case, both TikTok and Toutiao were subsidiaries of ByteDance. Thus, positive sentiment dominated (86.15%) when ByteDance communicated the crisis on Toutiao, and negative sentiment dominated (42.66%) when ByteDance's crisis communication announcement was retweeted by other users on Weibo.

This may have two reasons. First, different social media platforms have different user attributes, and researchers have found evidence of this by comparing Facebook and Twitter. For example, in US, 71% of adults use Facebook, whereas only 23% use Twitter (Pew Research Center, 2014). As of 2021, no study had focused on analyzing user-attribute differences on Chinese social media. Although we do not have experiments or questionnaires, our SNA analysis confirmed that users of Toutiao more significantly trusted official announcements from ByteDance, whereas users of Weibo showed disapproval and skepticism toward ByteDance. This is probably since Toutiao is a product of ByteDance, and Toutiao users present a love and bias for the CEO of ByteDance; therefore, Toutiao users are naturally more biased toward ByteDance, whereas this is not the case with Weibo users.

Second, users have different channels for obtaining information. Jin et al. (2014) reported that the public is most likely to accept organizational avoidance responses when they perceive the source of the crisis to be external and the crisis message is sent directly from the organization. In this study, Toutiao users received crisis communication from ByteDance's official Toutiao account, while Weibo users gained access to content retweeted by Weibo's third-party users. Thus, Toutiao users were more likely to endorse ByteDance's statements, whereas Weibo users' acceptance rates were likely to be less.

Therefore, we recommend expanding on the conclusions of Jin et al. (2014). As summarized in Table 18, when the public believes that the crisis originated externally and the social media used for crisis communication is part of the same enterprise group as the organization in crisis, the public is most likely to accept the organization's defensive response (denying or diminishing) to a crisis. However, when the social media used by an organization for crisis communication is not part of the same corporate group as the organization (crisis communication is issued by a third party), the probability of public acceptance is significantly less.

In the SNA, we found Weibo users using adjectives related to byte skipping; for example, Weibo users thought byte skipping was cowardly. Research on this point is limited, with only one study suggesting that viewing companies as moral agents with an identity is philosophically problematic (Ashman and Winstanley, 2007), and that it does not stop social media users from holding such anthropomorphic viewpoints when they view companies. Social media users who read a company's crisis communication content may use that content to construct an anthropomorphic image of the company in their minds. If the crisis communication content is tough, social media users may construct an image of a tough company; if the crisis communication content is passive, the corresponding image may be coward. We believe that this is an exciting finding in crisis management.

Practical contribution. Companies should essentially adopt a multiplatform approach when making crisis communication announcements (Quesenberry, 2020). By utilizing multiple social media outlets, companies can effectively reach a wider audience and engage with diverse user demographics. Neglecting influential platforms within a specific market, as exemplified by ByteDance's exclusive focus on Toutiao while overlooking Weibo, can result in passivity toward public opinion on the neglected platform.

For instance, during the COVID-19 pandemic, numerous government organizations used multiple social media platforms to disseminate crisis-related information and updates (Waeterloos et al., 2021). They strategically leveraged platforms, such as Twitter, Facebook, Instagram, and LinkedIn, to ensure maximum reach and engagement. This approach allowed companies to tap into different user communities and effectively address the concerns of diverse stakeholder groups.

Furthermore, our study highlights the importance of understanding distinct user perceptions and levels of trust associated with different social media platforms. For example, users of Toutiao and Weibo may have varying preferences, demographics, and cultural backgrounds that can influence their interpretations of crisis communication messages. Therefore, companies must acknowledge that crisis communication content can elicit different responses and outcomes, depending on the platform used.

Previous research has shown that during product recalls, companies that employed a multi-platform crisis communication strategy observed divergent reactions across different social media channels. While positive sentiments and support were prominent on certain platforms, others experienced a more critical and skeptical responses. This discrepancy underscores the need for companies to tailor their crisis communication messages and strategies to suit the characteristics and preferences of each platform's user base.

In conclusion, adopting a multi-platform approach to crisis communication enables companies to proactively address diverse user perspectives and enhance their overall response effectiveness. By considering the specific features, user demographics, and trust dynamics of various social media platforms, companies can strategically engage with their target audiences, build trust, and effectively manage crises in the digital era.
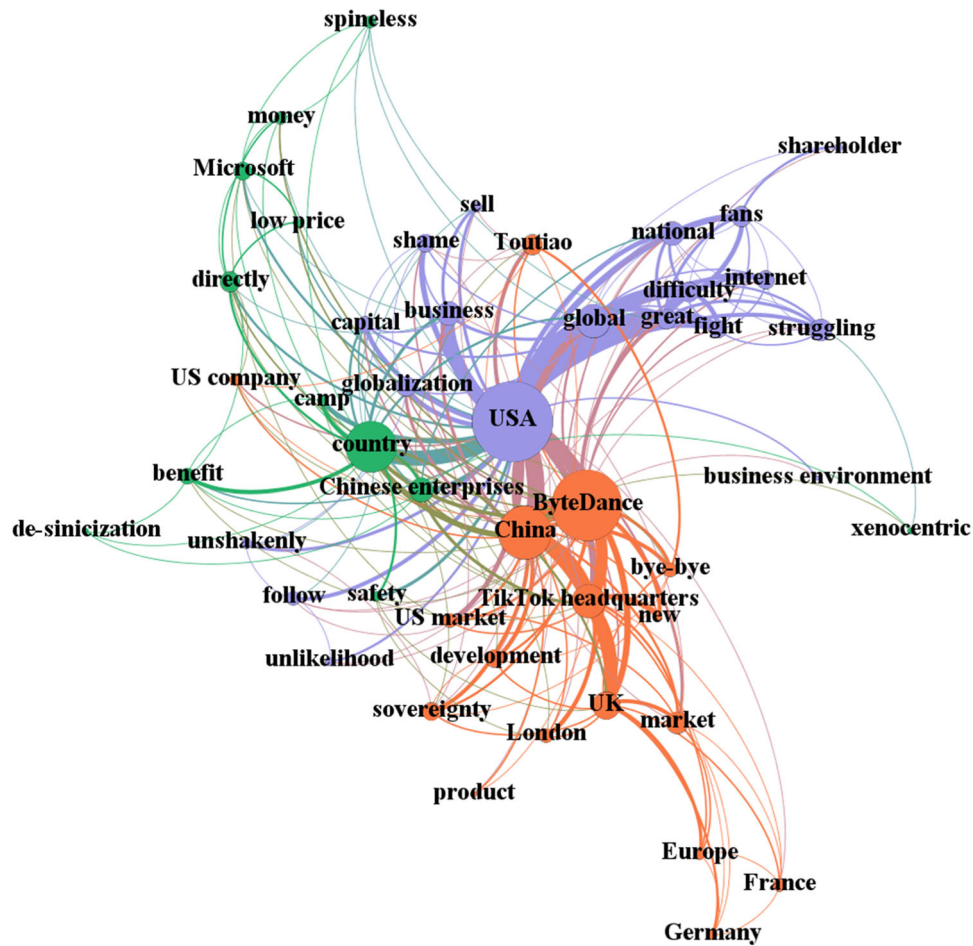
Fig. 7 Semantic network of neutral comments on Toutiao. The network indicates that there are two communities.

Fig. 8 Semantic network of neutral comments on Weibo. The network indicates that there are six communities.

Conclusion

This study fills a gap in the comparative analysis of crisis communication in the Chinese context and represents the first investigation of public opinion on Toutiao. Guided by SMCC theory and using the case of the Trump administration's ban on TikTok, we examined ByteDance's crisis communication strategies in the Chinese market. As ByteDance conducted crisis communication exclusively on Toutiao, neglecting Weibo's public opinion fermentation, we compared the impact of crisis communication on Toutiao and Weibo users using machine learning and deep learning-based sentiment classification, along with SNA. The contributions of this study are as follows:

Fig. 9 Semantic network of negative comments on Toutiao. The network indicates that there are three communities.

No.	Topic descriptions	Colors	Ratios
	Table 15 Topics for neutral comments on Weibo.		
1	Patriotism is the bottom line of enterprise development.	Purple	34%
2	ByteDance selling its share of the US market is a way to minimize losses.	Light green	26%
3	Pro-American vs. patriotic.	Blue	16%
4	The globalization of enterprises cannot be separated from the country's support.	Brown	14%
5	Debate among commenters.	Dark green	6%
6	Trump's administrative crackdown on TikTok violates America's free trade.	Pink	4%

No.	Topic descriptions	Colors	Ratios
	Table 16 Topics for negative comments on Toutiao.		
1	It is better to get out of the US market than sell to Microsoft.	Purple	40%
2	Moving TikTok's headquarters to London will not work either.	Orange	35%
3	If ByteDance sells TikTok's American company, the Chinese government will take over ByteDance.	Green	25%

First, we found that users of different social media platforms exhibited different sentimental responses to the same crisis influenced by diverse information channels.

Second, social media users tend to attribute personified character traits to companies.

Finally, we recommend that companies engage in crisis communication across multiple social media platforms, not limited to a single platform, while acknowledging the influential platforms in the market.

Additionally, this study addresses the gap in exploring variations in crisis communication across different social media platforms in the Chinese context, and it stands as a pioneer in analyzing public opinion on Toutiao.

Limitations

We must further explore the modes of crisis communication on different social media platforms and the relationship between social media platforms and user attributes. The TF-IDF algorithm used in this study is simple and fast, and its results are more realistic. However, the TF-IDF algorithm cannot reflect the position information of words, and the words that appear in the
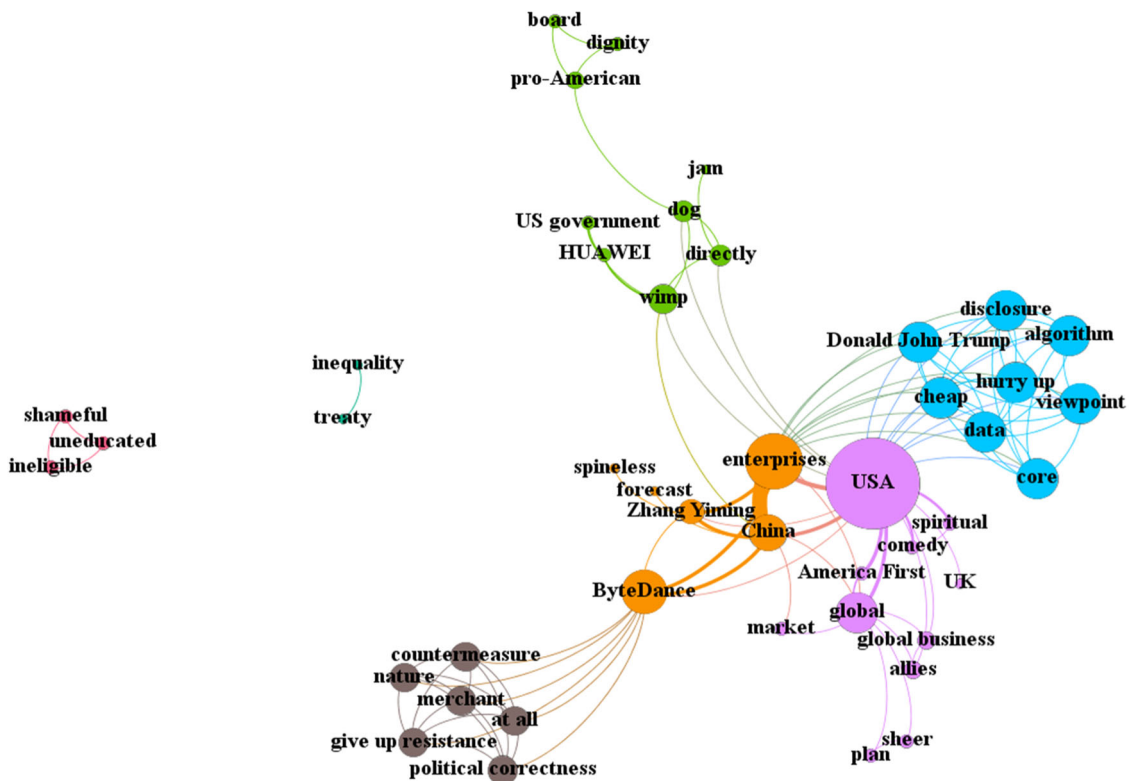
Fig. 10 Semantic network of negative comments on Weibo. The network indicates that there are seven communities.

Table 17 Topics for negative comments on Weibo.

No.	Topic descriptions	Colors	Ratios
1	If ByteDance sells to the US market now, the US allies will ask ByteDance to sell to their markets in the future.	Purple	25%
2	Zhang Yiming is Pro-American.	Light green	20%
3	Weibo users hoped Zhang Yiming could sell TikTok thoroughly, including algorithms and data (sarcasm).	Blue	17%
4	ByteDance cowardly.	Orange	14%
5	ByteDance's management is a merchant, and the merchant is out to make money.	Gray	13%
6	Weibo users are unhappy with Zhang Yiming.	Pink	7%
7	The US government's handling of TikTok is a treaty of inequality.	Dark green	4%

Table 18 Acceptance of defensive response strategy by the public.

Crisis originated externally	Social media (Belonging to the same enterprise group as the organization) Defensive response strategy	Social media (Not belonging to the same enterprise group as the organization) Defensive response strategy
Organization	High acceptability	—
Third party	—	Low acceptability

front position are considered to be of the same importance as those that appear in the back position, which is worth considering. For example, in the comments section of social media, comments with high likes or retweets are more likely to be recognized by all users. In the future, we can assign more weight to the words in the comment based on the number of likes or the ranking acquired by the comment.

Data availability

The datasets generated during the current study are available in the Dataverse repository, https://doi.org/10.7910/DVN/DXSSZH.

References

Arora D, Li KF, Neville SW (2015) Consumers' sentiment analysis of popular phone brands and operating system preference using Twitter data: a feasibility study. In: *Proceedings of the IEEE 29th international conference on advanced information networking and applications,* IEEE, pp 680–686

Ahamad D, Mahmoud DAMM, Akhtar MM (2017) Strategy and implementation of web mining tools. Int J Innov Res Adv Eng 4:01–07

Ashman I, Winstanley D (2007) For or against corporate identity? Personification and the problem of moral agency. J Bus Ethics 76(1):83–95

Austin L, Fisher Liu B, Jin Y (2012) How audiences seek out crisis information: exploring the social-mediated crisis communication model. J Appl Commun Res 40(2):188–207

Blanco G, Lourenço A (2022) Optimism and pessimism analysis using deep learning on COVID-19 related twitter conversations. Inf Process Manag 59(3):102918

Bruns A, Burgess J (2014) Crisis communication in natural disasters: the Queensland floods and Christchurch earthquakes. Twitter Soc [Digit Form] 89:373–384

Cai Y, Ke W, Cui E, Yu F (2022) A deep recommendation model of cross-grained sentiments of user reviews and ratings. Inf Process Manag 59(2):102842

Chan-Olmsted SM, Cho M, Lee S (2013) User perceptions of social media: a comparative study of perceived characteristics and user profiles by social media. J Commun Media Technol 3(4):149–178

Che S, Wang X, Zhang S, Kim JH (2023) Effect of daily new cases of COVID-19 on public sentiment and concern: deep learning-based sentiment classification and semantic network analysis. J Public Health, 1–20. https://doi.org/10.1007/s10389-023-01833-4

Che S, Nan D, Kamphuis P, Zhang S, Kim JH (2022) Examining crisis communication using semantic network and sentiment analysis: a case study on NetEase Games. Front Psychol 13:823415–823415

Che S, Kim JH (2023) Sentiment impact of public health agency communication strategies on TikTok under COVID-19 normalization: deep learning exploration. J Public Health, 1–12. https://doi.org/10.1007/s10389-023-01833-4

Cheng Y, Wang Y, Kong Y (2022) The state of social-mediated crisis communication research through the lens of global scholars: an updated assessment. Public Relat Rev 48(2):102172

Chung DS, Jeong HJ, Lee S, Nah S (2022) News credibility revisited: the roles of news comment engagement and news literacy on news portal credibility in South Korea. Asian J Commun 32(4):371–391

Drieger P (2013) Semantic network analysis as a method for visual text analytics. Proced-Soc Behav Sci 79:4–17

Eriksson M (2012) On-line strategic crisis communication: in search of a descriptive model approach. Int J Strat Commun 6(4):309–327

Fraustino JD, Liu BF, & Jin Y (2017) Social media use during disasters 1: a research synthesis and road map. Soc Media Crisis Commun, 283–295. https://doi.org/10.4324/9781315749068

Gulati K, Kumar SS, Boddu RSK, Sarvakar K, Sharma DK, Nomani MZM (2022) Comparative analysis of machine learning-based classification models using sentiment classification of tweets related to COVID-19 pandemic. Mater Today Proc 51:38–41

Hota HS, Sharma DK, & Verma N (2021) Lexicon-based sentiment analysis using Twitter data: a case of COVID-19 outbreak in India and abroad. In Data Science for COVID-19, pp 275–295. Academic Press. https://doi.org/10.1016/B978-0-12-824536-1.00015-0

Jiao H, Wang Y, Xiao H, Zhou J, Zeng W (2017) Promoting profit model innovation in animation project in northeast Asia: case study on Chinese cultural and creative industry. Sustainability 9(12):2361

Jin Y (2010) Making sense sensibly in crisis communication: How publics' crisis appraisals influence their negative emotions, coping strategy preferences, and crisis response acceptance. Commun Res 37(4):522–552

Jiang J, Huang YH, Wu F, Choy HY, Lin D (2015) At the crossroads of inclusion and distance: organizational crisis communication during celebrity-endorsement crises in China. Public Relat Rev 41(1):50–63

Jin Y, Liu BF, Austin LL (2014) Examining the role of social media in effective crisis management: the effects of crisis origin, information form, and source on publics' crisis responses. Commun Res 41(1):74–94

Kim D, Nam Y, Kang S (2010) An analysis of corporate environmental responsibility on the global corporate Web sites and their dialogic principles. Public Relat Rev 36(3):285–288

Kim J, Kim J (2018) The impact of imbalanced training data on machine learning for author name disambiguation. Scientometrics 117(1):511–526

Kuipers S, Schonheit M(2022) Data breaches and effective crisis communication: a comparative analysis of corporate reputational crises. Corp Reput Rev 25(3):176–197. https://doi.org/10.1057/s41299-021-00121-9

Li H, Chen Q, Zhong Z, Gong R, Han G (2022) E-word of mouth sentiment analysis for user behavior studies. Inf Process Manag 59(1):102784

Liu BF, Austin L, Jin Y (2011) How publics respond to crisis communication strategies: the interplay of information form and source. Public Relat Rev 37(4):345–353

Liu J, Zhao H (2021) Privacy lost: appropriating surveillance technology in China's fight against COVID-19. Bus Horizons 64(6):743–756

Liu W, Lai CH, Xu WW (2018) Tweeting about emergency: a semantic network analysis of government organizations' social media messaging during hurricane Harvey. Public Relat Rev 44(5):807–819

Mak AK, Song AO (2019) Revisiting social-mediated crisis communication model: the Lancôme regenerative crisis after the Hong Kong Umbrella Movement. Public Relat Rev 45(4):101812

Ngai CS, Jin Y (2016) The effectiveness of crisis communication strategies on Sina Weibo in relation to Chinese publics' acceptance of these strategies. J Bus Tech Commun 30(4):451–494

Obembe D, Kolade O, Obembe F, Owoseni A, Mafimisebi O (2021) Covid-19 and the tourism industry: an early stage sentiment analysis of the impact of social media and stakeholder communication. Int J Inf Manag Data Insights 1(2):100040

Park S, Kim J (2021) Tweeting about abusive comments and misogyny in South Korea following the suicide of Sulli, a female K-pop star: Social and semantic network analyses. El Prof Inf, 30(5). https://doi.org/10.3145/epi.2021.sep.05

Pew Research Center (2014) Social Media Site Usage 2014 http://www.pewinternet.org/2015/01/09/social-media-update-2014/ (accessed 9 Sep 2015)

Quesenberry KA (2020) Social media strategy: marketing, advertising, and public relations in the consumer revolution. Rowman & Littlefield Publishers

Su L, Stepchenkova S, Kirilenko AP (2019) Online public response to a service failure incident: Implications for crisis communications. Tour Manag 73:1–12

Sun H, Wang G, Xia S (2021) Text tendency analysis based on multi-granularity emotional chunks and integrated learning. Neural Comput Appl 33(14):8119–8129

Uma AN, Fornaciari T, Hovy D, Paun S, Plank B, Poesio M (2021) Learning from disagreement: a survey. J Artif Intell Res 72:1385–1470

Waeterloos C, Walrave M, & Ponnet K (2021) The role of multi-platform news consumption in explaining civic participation during the COVID-19 pandemic: a communication mediation approach. New Media Soc, 0(0). https://doi.org/10.1177/14614448211058701

Wang Y (2016) Brand crisis communication through social media: a dialogue between brand competitors on Sina Weibo. Corp Commun Int J

White CM (2011) Social media, crisis communication, and emergency management: leveraging Web 2.0 technologies. CRC press

Yarchi M, Baden C, Kligler-Vilenchik N (2021) Political polarization on the digital sphere: a cross-platform, over-time analysis of interactional, positional, and affective polarization on social media. Political Commun 38(1-2):98–139

Yoo M, Lee S, Ha T (2019) Semantic network analysis for understanding user experiences of bipolar and depressive disorders on Reddit. Inf Process Manag 56(4):1565–1575

Yoon SW, Chung SW (2021) Framing the EU: big data analysis of South Korean news media. Sustainability 13(4):1621

Zhang C, Lin D, Cao D, Li S (2021) Grammar guided embedding based Chinese long text sentiment classification. Concurr Comput Pract Exp 33(21):e6439

Zhao H (2017) The impacts of contextual factors on social media crises: Implications for crisis communication strategy selection. Int J Strateg Commun 11(1):42–60

Zhao H (2020) Contextual awareness on organizational crises: national context and crisis attribution. Public Relat Inquiry 9(1):61–79

Zhao H, Liu Z, Yao X, Yang Q (2021) A machine learning-based sentiment analysis of online product reviews with a novel term weighting and feature selection approach. Inf Process Manag 58(5):102656

Zhao X, Oh HJ (2021) What fosters interorganizational frame convergence: examining a semantic network during the opioid crisis. Public Relat Rev 47(3):102042

Zhou F, Mou J, Wang W, & Wu YJ (2021) Social media usage and employee creativity: is relational energy a missing link? Online Inf Rev

Zimand-Sheiner D, Levy S, Eckhaus E (2021) Exploring negative spillover effects on stakeholders: a case study on social media talk about crisis in the food industry using data mining. Sustainability 13(19):10845

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SC: Conceptualization, writing, and editing. YZ: Data analysis. SZ: Research design. DN: Revision suggestion. JK: Full guidance.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

This article does not contain any studies with human participants or animals performed by any of the authors.

Additional information

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